

**HOSTILITY, SMILING AND ELICITED EMOTIONAL EXPERIENCES:
CONSIDERATIONS FOR HEALTH OUTCOMES**

by

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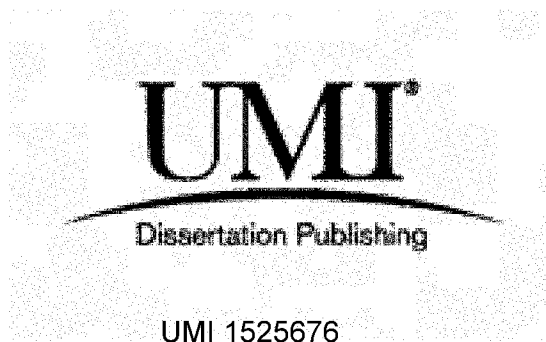
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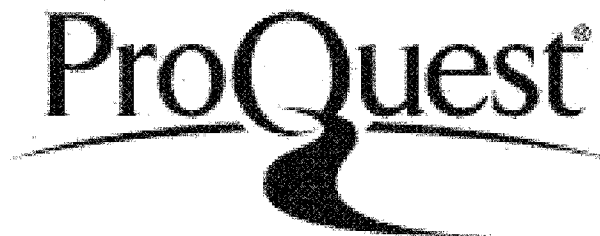


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Abstract

Resilience is an increasingly invoked theoretical construct to explain why and how people manage to retain their health despite experiencing adversity. Improved vagal tone (higher heart rate variability; HRV) is supported in the literature as an indicator of positive cardiovascular health outcomes. Utilizing a measure of HRV as a proxy for health resilience outcomes, historical datasets of healthy undergraduate students were utilized to elucidate the relationship between measured hostility (high and low), evoked emotions (happy and angry) and smiling behaviours to better understand some factors contributing to positive physiological health (i.e., heart rate variability as an indicator of positive health outcomes). Results indicate that smile parameters vary meaningfully as a function of the type of elicited emotion interview participants undergo and as a function of gender and hostility level. However, the smiling behaviour was not predictive of physiological outcomes.

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We miss you.

Theoretical Context

Resilience is the ability to negotiate and maintain positive life adaptation despite significant adversity or “risk” faced in life (Luthar, 2006). The determinants of resilience are thought to include psychophysiological processes that allow people to regulate the autonomic and neuroendocrine effects of stress (Miller, Chen, & Cole, 2009; Pressman & Cohen, 2005); however, discrete links between the factors thought to contribute to health resilience are relatively sparse in the present literature. In general, current literature emphasizes the importance of cognitive, affective and behavioural components of health risk (factors negatively impacting health) and associated resilient outcomes (positive factors despite health risk), but research efforts focusing on resilience are segregated by given research contexts (i.e., biological versus state and trait theories versus culture theories, and so on). While much of the literature has implicated risk factors (i.e., negative emotions such as anger, anxiety, depression) in morbidity and mortality from a range of illnesses, including cardiovascular disease (Barefoot et al., 2000; Kubzansky & Kawachi, 2000), other research has suggested the importance of examining contributors to positive health outcomes (Richman, et al., 2005; Ryff & Singer, 1998). The proposed study considers four main factors in the context of resilience: hostility, evoked emotion (specifically, happiness and anger), smiling behaviours, and heart-rate variability. Each of these factors is supported in the literature as a possible contributing factor to health outcomes, and therefore, theoretically to the concept of health resilience. The study endeavored to elucidate these four factors in the context of health resilience and to draw some conclusions about potential avenues for further studies in the continuing quest to clarify factors contributing to health resilience.

Resilience

History of resilience theory. Over the past 40 years, the concept of resilience has received a wide range of attention in the literature (Anthony & Cohler, 1987; Bonanno, 2004a, 2004b, 2005; Cicchetti & Garmezy, 1993; Kaplan, 1999; Luthar & Cicchetti, 2000; Masten, 2001; Ungar, 2004, 2006a, 2006b, 2007; VanBreda, 2001; Werner & Smith, 1992). The idea that there is something different about those individuals who are able to ‘beat the odds’ seems to have fueled a surge in research that revolves around understanding what it is that differentiates those individuals who do well despite adversity, from those who do not (Grotberg, 2003). As the concept has gained popularity, many different approaches and explanations for resilience have come forth. The early trait and characteristic studies such as in Anthony and Cohler’s work, *The Invulnerable Child* (1987) eventually led to the efforts of researchers such as Luthar and Cicchetti (2000) focused on refining concepts and creating guidelines for the future of resilience research. More recently, efforts such as that of Ungar (2006) have been to move the study of resilience toward a more culturally aware and applied approach. Despite these diverging lines of research, there has been relative concurrence as to the definition of resilience. In general, resilience is considered to be “positive adaptation [which] is manifested in life circumstances that usually lead to maladjustment” (Luthar, 2006, p. 739).

Current conceptualizations of resilience. Masten and Coatsworth (1998) argued that, in order to infer resilience, two fundamental judgments about a person’s life must be made: 1) the person is coping in a positive way and 2) the person has, is presently, or will in the very near future, face a significant adversity. Ungar (2006) takes the study of resilience to the community level by defining resilience in the following terms: “Resilience is both an individual’s capacity to navigate to health resources and a condition of the individual’s family, community, and culture

to provide these resources in culturally meaningful ways” (Ungar, p. 55). For resilience to be implicated, an individual must face significant adversity, and in the face of such adversity exercise the abilities outlined above. Further, the community and culture must rise to the challenge and be available, accessible, and salient for the individual’s navigation.

Resilience theory allows us to develop an understanding about protective factors that may not typically be considered as such. For example, in 2005, Bonanno differentiated between resilience and recovery by indicating that *resilience* following potentially traumatic events represents a distinct outcome trajectory from that typically associated with *recovery* from trauma. Resilience is characterized by *relatively mild and short-lived disruptions with a stable trajectory of healthy functioning across time*, and recovery is represented by *a moderate to severe initial elevation in psychological symptoms, where normal functioning is disrupted and the elevation gradually declines in psychological symptoms*. Studies by Bonanno and others have linked resilience to continued fulfillment of personal and social responsibilities and the capacity for positive emotions and generative experiences, both immediately and in the months following the traumatic event (Bonanno & Kelner, 1997; Bonanno, Wortman, et al., 2002; Fredrickson et al., 2000). Social lore tends to view individuals who continue to present fulfillment of personal and social responsibilities as a person “in denial of the truth” or by “coping through avoidance.” Indeed, the ability to continue to demonstrate *resilience*, as opposed to *recovery*, in response to trauma suggests positive health outcomes. Not only a distinct outcome, resilience was also found to be the most common process following exposure to a potentially traumatic event (Bonanno et al., 2005).

Finally, and perhaps key to the current study, Bonanno (2005) goes on to state that *adaptive flexibility* is a key factor in resilience, whereby it is noted in some circumstances

behaviour is considered health promoting, but in a different circumstance the same behaviour may be maladaptive. For example, expression of anger may be maladaptive in particular circumstances due to the potential negative impact on relationships; however, if the alternative is to repress the anger potentially having a negative impact on wellbeing, expression in a manner that would spare relationships could be considered adaptive. This kind of flexibility has been identified as an important contributor to resilience. Ungar (2006) underlines Bonanno's research (2004) and further indicates that resilience is an adaptive process that requires more than just the individual, but also the contribution of the environment and community. Thus, to achieve resilience, the onus is jointly on the individual and the environment. The individual must negotiate resources and behave flexibly in order to manage and maintain relative normalcy in psychological equilibrium. However, this cannot be achieved without salient resources provided by the environment that match the needs and abilities of the individual.

Physiology and resilience. The modern biology literature provides a framework for understanding the interplay of factors contributing to pathophysiology and disease. Specifically, the concept of *allostasis* (maintaining stability through change) is depicted as a “fundamental process through which organisms actively adjust to both predictable and unpredictable events” (McEwen & Wingfield, 2002, p. 2). McEwen and Wingfield's (2002) concept of allostasis provides a framework at the physiological level, which can guide understanding of the parallel concept of *resilience* at the psychological level. Specifically, they refer to *homeostasis* and *allostasis*, the former defined as *the stability of physiological systems that maintain life within an optimal range for the current life history stage*, and the latter considered *the process of achieving stability through change whereby the organism adapts physiological boundaries to accommodate for various changes affecting the organisms* (i.e., social interactions, environment,

etc.). Allostasis is differentiated from homeostasis as *that which maintains systems in balance*, as opposed to that which sustains life. *Allostatic state* is the altered and sustained activity levels (i.e., system imbalance) of the primary mediators of allostasis. These primary mediators integrate physiology and associated behaviours in response to the changing environment and challenges (i.e., social interactions, weather, disease, predators, pollution, etc.) Allostatic state can be sustained in the short term in order to support adaptation, however, if sustained in the long-term dysfunction typically occurs. The negative health impacts of chronic stress are an example of the consequences of a prolonged allostatic state.

The most important feature of the mediators associated with allostasis is the protective effect they provide in the short run and, conversely, the damaging effects that occur over longer time intervals (McEwen, 1998). To draw the comparison back to the concept of resilience in the broader context, Bonanno (2005) has argued that adaptive behaviours in the face of adversity may be maladaptive in other circumstances. For example, research has shown that those given to self-serving bias (the tendency to overestimate one's own positive qualities) tend to be perceived negatively by other people and more narcissistic than others. However, Bonanno and colleagues (2002) examined individuals in two separate samples dealing with specific powerful stressor events (the premature death of a spouse and exposure to urban combat during the civil war in Bosnia, respectively) and found that self-serving bias, as rated by health experts, was positively associated with ratings of functioning. Thus, where a particular behaviour is a potential hindrance in one circumstance (i.e., leading to negative perceptions of others), it is considered helpful in another (i.e., a more resilient response to powerful stressor events). *Adaptive flexibility* appears to be a key to understanding the process of resilience. Ray (2004) further aligns the concepts of allostasis and resilience by stating that the balance between an individual's

coping skills and the environmental demands of the individual determines equilibrium or disequilibrium. Taken together, the evidence in the literature suggests psychophysiological factors are of important interest when considering the pathways to coping with adversity. Thus, to understand the crucial query “what is different about those who do well from those who do not” it is logical to consider psychophysiological factors.

There has been a surge of recent research connecting psychosocial factors with physiological changes to consider the pathways to disease. Miller, Chen, and Cole (2009) identify numerous studies that exemplify mechanisms by which relatively transient psychosocial conditions can bring about long-term or permanent change at the physiological level. Historically, there has been a research trend toward considering factors contributing to disease and negative health outcomes. More recently, however, there has been a revival of focus on the World Health Organization’s 1948 definition, turning attention toward factors specifically contributing to wellbeing (physical, mental, and social) where it is recognized that the absence of disease does not necessarily denote health and wellbeing (Ray, 2004). Some of the areas researchers are exploring to better understand predictors of positive health outcomes include emotions (such as happiness) and trait-states (such as hostility).

Emotions and Health

The smile and emotion: Theoretical constructs. There is research to suggest that positive emotions are associated with positive health factors. For example, positive emotions have been reported to improve cognitive and social resources (Fredrickson, 1998, 2001a, 2001b; Fredrickson & Joiner, 2002), reduce negative emotions (Fredrickson & Levenson, 1998; Fredrickson, Mancuso, Branigan, & Tugade, 2000), and generally reduce distress (Bonanno & Keltner, 1997; Folkman & Maskowitz, 2000; Fredrickson, 1998, 2001a, 2001b; Levenson, 1988;

Moskowitz, Folkman, & Acree, 2003). Additionally, in the exploration of relationships between positive emotions and positive health outcomes, researchers have started linking positive affect and physiological changes implicated in health. For example, Futterman and colleagues (1994) noted the influence of positive affect on improved immune function. Research by Cohen et al. (2003) has linked positive emotional styles with increased resistance to the common cold, and others have shown a link between positive emotional experiences and longevity (Danner, Snowden, & Friesen, 2001).

Research on positive emotions must be based on some kind of indicator of their presence. Among the possible indicators of a positive emotion, the human smile has certain advantages because it is objectively observable, salient and frequent. The smile can be conceived of in two specific ways relevant to understanding how it might relate to health. According to the emotional readout perspective, the smile is hypothesized to be intrinsically linked to internal affective states (Ekman, 1982, 1992a; Ekman & Friesen, 1969). From the behavioural ecology perspective, however, the smile is considered an expression of intention movements, signaling to others probable future actions, and thus, playing an important role in social regulation (Prkachin & Silverman, 2002). Both conceptions of the smile are salient to understanding its role in health resilience.

Recent emotion research has distinguished between two different kinds of smiling: the Duchenne smile and the non-Duchenne smile. Named for the French neuroanatomist Guillaume Duchenne de Boulogne, the Duchenne smile has been characterized by the Facial Action Coding System (FACS; Ekman & Friesen, 1978; Ekman, Friesen, & Hager, 2002), which is a system for coding visible facial movements. Specifically, the Duchenne smile is coded based on the presence of two facial movements: first, the zygomaticus major muscle (coded as Action Unit

[AU] 12 in FACS), which pulls the lip corners up obliquely, resulting in the characteristic appearance of a smiling mouth; second, the orbicularis oculi pars lateralis muscle (AU 6 in FACS), which results in cheeks lifting, eye openings narrowing, and the presence of wrinkles around the eye socket (Ekman & Friesen, 1978; Ekman, Frisen & Hager, 2002; Krumhuber & Manstead, 2009). The Duchenne smile has been characterized as a “genuine smile.” That is, it is considered a spontaneous and genuine expression of positive emotions such as happiness, pleasure, or enjoyment (Ekman, 1992b; Ekman, Davidson, & Friesen, 1990; Ekman & Friesen, 1982; Frank & Ekman, 1993; Frank, Ekman, & Friesen, 1993; Keltner & Bonanno, 1997; Krumhuber & Manstead, 2009).

The non-Duchenne smile is defined as one that does not involve contraction of the orbicularis muscles. In the non-Duchenne smile, only the mouth region moves—there is no characteristic change in the region around the eyes. The non-Duchenne smile is believed not to be associated with the experience of positive emotion (Ekman & Friesen, 1978; Ekman, Friesen & Hager, 2002; Krumhuber & Manstead, 2009.) Rather, it is considered a “false” or a *social, polite, or masking* smile (Ekman, 1982). Some researchers suggest that the common function of non-Duchenne smiles is to convince another person that enjoyment is occurring when it is not for the purposes of communicating social politeness or deception or appeasement (Bonanno et al., 2002; Ekman & Friesen, 1982; Frank, Ekman, & Friesen, 1993; Keltner, 1995.) Duchenne smiles are believed to function in various ways and have been linked with numerous social benefits (Bonanno et al., 2007). Specifically, a Duchenne smile can signal affiliative intent, and therefore, invite others to approach (Borkenau & Liebler, 1992; Frank et al., 1993; Frijda & Mesquita, 1994; Keltner & Kring, 1998). Research has connected Duchenne smiles to group cohesiveness (Vinton, 1989); regulation of conversation (Provine, 1993); and positive responses

from, and relations with, others (Haviland & Lelwica, 1987; Keltner & Kring, 1998; Matsumoto & Kudoh, 1993).

As previously noted, despite much research regarding the function of smiles, some of the research is split about whether smiles (Duchenne and non-Duchenne) are expressions of emotion states or are, in fact, intentional behaviours meant to convey information about what the expresser is going to do. Gervais and Wilson (2005) provide an excellent review of Duchenne and non-Duchenne behaviours that outlines the various understandings of laughter and humour from an evolutionary functional perspective. Notable within this review is the importance of distinguishing between Duchenne and non-Duchenne smiles, laughter, and humour. The authors point out that much of the literature neglects the implications of this distinction for the evolution of smiling and laughter as a *signal* (as opposed to a pure *expression of emotion*). The authors further propose an evolutionary framework that considers smiling, laughter, and humour as a “pre-adaptation that was gradually elaborated and co-opted through biological and cultural evolution” (Gervais & Wilson, 2005, p. 296.) Specifically, the authors conclude Duchenne expressions to be a medium for emotional contagion, which evolved via the promotion of resource-building social play. They further postulate that the prior existence of Duchenne expressions allowed for the adaptation of non-Duchenne expressions, which initially developed to serve a novel function from Duchenne expressions. The main distinction drawn between Duchenne and non-Duchenne expressions by Gervais and Wilson (2005) is the “inherent link [of Duchenne expressions] with emotional experience.” Duchenne expressions are thought to be intrinsically linked to the ancient brain circuit that underlies mammalian ‘rough-and-tumble play’ which is mediated in part by pain-reducing opioids (Panksepp, 2000), whereas non-Duchenne smiles are not thought to be directly linked with emotional expression and developed as adaptive

mechanisms to moderate social circumstances (Gervais & Wilson, 2005). Some researchers would argue the modern-day smile, whether Duchenne or non-Duchenne, is less linked to emotional expression than it is to social functioning. Despite some controversy over the purpose of smiles (particularly non-Duchenne smiles), smiling is commonly utilized as a measure of positive emotion in the literature.

Methods in studying emotion communication. Given literature indicating that smiles are intrinsically linked to feelings, and feelings are implicated in health outcomes, presumably, different types of smiles may provide information about a person's emotions and associated health outcomes. Recently, Papa and Bonanno (2008) have examined *interpersonal* and *intrapersonal* functions of smiling in positive and negative affective contexts. In this study, researchers measured smiles during a lab-based monologue task following the viewing of a film that evoked a particular emotion (either happiness or sadness). Also, longitudinally measured were psychological adjustment and social integration using data obtained in years prior to, and following, the experimental task. Conclusions from this research suggest that Duchenne smiles, in addition to signaling happiness, serve the purpose of *a) self-regulation*, and *b) increasing the type of social resources that foster coping with adversity*. The results of the study also indicated the Duchenne smile better predicted long-term adjustment. Duchenne smiles were also associated with undoing of negative emotions during the experimental monologue task and with enhanced social integration outside the laboratory (Papa & Bonanno, 2008). This research offers a segue into further exploring the implications of smiles and their function as mediating factors contributing to health resilience.

Westphal, Seivert, and Bonanno (2010) draw attention to the construct of *expressive flexibility (EF)* as a positive predictor of adjustment. Specifically, this research explored the

hypothesis that the ability to flexibly modulate emotional expressions in accordance with situational demands is more important for adjustment than the reliance on a specific expressive regulation strategy (i.e., expression or suppression of emotions). The concept of *EF* is based on a culmination of research that suggests both suppression and expression of emotion have different and important interpersonal and intrapersonal functions. Specifically there is research to indicate that habitual suppression of emotion and expressive inhibition is associated with pervasive and long-term emotional, social, cognitive, and health costs (Butler et al., 2003; Gross & John, 2003; Gross & Levenson, 1993, 1997; Richards, Butler, & Gross, 2003). However, there is also research to support the adaptive benefits of suppression or down-regulation of emotion (Bonanno & Keltner, 1997; Gross & Munoz, 1995; Keltner, Kring, & Bonanno, 1999; Kennedy-Moore & Watson, 2001). Finally, there is research to indicate that expression of emotions can be maladaptive. For example, Adler and Matthews (1994) showed that chronic expression of negative emotion (i.e., anger) is a risk factor for cardiovascular disease. Additionally, Bonanno and colleagues (2007) showed that for survivors of childhood sexual abuse, in some contexts, even the expression of positive emotion could be maladaptive. Therefore, the culmination of this research has led some researchers to pursue the hypothesis that the ability to flexibly modulate emotional expressions in accordance with situational demands (or, *EF*) is more indicative of adjustment than reliance on any specific expressive regulation strategy (Westphal, Seivert, Bonanno, 2010).

To explore the hypothesis that *EF* is a predictor of adjustment, Bonanno and colleagues (2004) adapted Gross and Levenson's (1993) between-subjects paradigm developed to explore emotional suppression. In Gross and Levenson's (1993) study, participants were instructed to conceal all outward signs of emotion and then exposed to emotional stimuli. Bonanno et al.

(2004) modified this paradigm by including two new components. Specifically, to measure individual ability to flexibly regulate emotional expression both upward and downward, a within-subjects task was added that included conditions for both the expression and suppression of emotions, and a control condition in which participants were instructed to behave as they normally would. Also, to measure EF as a predictor of long-term adjustment, a sample of college-aged students in New York shortly after the September 11th terrorist attacks were followed over the course of two years. The results of this study indicated that those participants who were better able to suppress **and** enhance the expression of emotion flexibly evidenced less distress by the end of the second year (Bonanno et al., 2004).

Expanding upon these conclusions, Westphal, Seivert, and Bonanno (2010) endeavored to 1) demonstrate the stability of EF across a 3-year period, 2) replicate the association between EF and positive adjustment using a more objective measure of adjustment, and 3) to show the positive relation between EF and adjustment as salient in the context of high levels of cumulative life stress when EF is measured under conditions of immediate threat. To measure the stability of EF over the course of 3-years, participants from the Bonanno et al. (2004) study were invited back to the laboratory after 3 years since they first participated. About half of the participants completed a protocol almost identical to the 2004 study to establish test-retest reliability. The other half participated in a modified version of the experiment meant to test context-dependent effects of EF on adjustment. To address the goal of improving the objectivity of the measurement of EF, the researchers addressed the psychometrics of the original enhancement/suppression tasks by including a new variable: *balanced EF* as distinguished from the *sum EF* variable used in the 2004 study. Additionally, an added component of anonymous ratings of participants' adjustment were obtained from their close friends, which was deemed to

be a more ecologically valid way to establish the adaptive value of EF and to test whether the relationship between EF and adjustment would be stable across different sources of information. Finally, in order to explore a positive relation between EF and adjustment in the context of high levels of cumulative life stress participants were asked to record the occurrence of recent significant life events on a weekly basis for 1-year.

Results of this study supported the hypothesis that EF is stable in the long-term. Also supported was the hypothesis that participants with high EF evidence more resilient outcomes in the context of cumulative life stress and those with low EF evidenced poorer adjustment when faced with a high number of potentially stressful life events. It was noted that high expressive *and* high suppressive skills are important as protective factors against stress. Finally, in efforts to provide a more objective measure of EF, researchers had friends rate the participants. When EF was measured in a neutral (non-stressful) context, it was associated with resilience to cumulative life stress. However, when EF was measured in a threatening context (with the use of a threat word prime), friend's ratings suggested that high EF participants actually functioned *better* when exposed to high levels of cumulative life stress. The researchers explain this in three possible ways: 1) participants with high EF function better with a high number of potentially stressful life events; 2) friends potentially overestimated the functioning of participants who demonstrated high EF in the context of immediate threat ~~and~~ high levels of cumulative life stress; and 3) friends' accurate or exaggerated perceptions of a participant's functioning in the midst of high levels of cumulative life stress may contribute to better adjustment by reinforcing participants' positive coping behaviours (Westphal, Seivert, Bonanno, 2010). The ability to flexibly regulate emotion in accordance with situational demands is a key factor in effective

adaptation to adversity as evidenced by the literature. Thus, the constructs of *adaptive flexibility* and *emotional flexibility* have implications in the arena of health resilience.

Hostility and health. While expressive behaviour may suggest the ability to self-regulate and increase access to coping resources to deal with adversity, the construct of hostility (*antagonism, cynicism, suspiciousness of others, proneness to experience and express anger*) has been implicated in the literature as a potential predictor of poorer health prognoses (Booth-Kewley & Friedman, 1987; Miller et al., 1996; Rozanski, Blumenthal & Kalplan, 1999; Smith, 1992). There is a wealth of literature linking hostility with coronary heart disease (Barefoot et al., 1983; Hecker et al., 1988; Irvine et al., 1991; Matthews et al., 1977; Shekelle et al., 1983). For example, Nelson and colleagues (2005) found that parasympathetic regulation was diminished during anger induction for individuals with high levels of trait hostility. The results of this work also suggest the possibility that coping mechanisms such as relaxation imagery may be effective to support coping with adversity in some groups. Specifically, high hostile individuals (men and women) with family histories of cardiovascular disease rated the increase in relaxation as a result of relaxation imagery as much greater than those with low hostility and no family history of cardiovascular disease. However, the physiological processes affected by strong feelings of anger and hostility has been less clearly defined (Nelson et al., 2005).

Convergent evidence suggests hostility may be associated with enhanced autonomic and neuroendocrine reactivity, however, this appears to be the case most readily in situations likely to elicit anger but not necessarily in non-anger producing stressful situations (Miller, Dolgoy, Friese & Sita, 1996; Suarez & Williams, 1989; Suls & Wan, 1993). The difficulty in elucidating the relationship between hostility and health outcomes is that hostility is generally understood to be a multidimensional construct (Suls & Wan, 1993). Thus, the link between hostility and health

outcomes, such as cardiovascular illness and disease may not be direct or linear. Suls and Wan (1993) report, “hostile individuals must experience an obvious threat to their self-esteem or feel that they have been treated unjustly before they produce an exaggerated physiologic response (pp.623).” Other research links hostility with health outcomes via health behaviours such that hostility is associated with increased unhealthy behaviours and decreased health-supporting behaviours (Leiker & Hailey, 1988; Scherwitz et al., 1992; Lipkus, Barefoot, Williams & Siegler, 1994). However, Smith (1992) suggests hostility is associated with risk via transaction between the hostile individual’s behaviours in the social world and the reciprocation of the social world as a result. Smith’s (1992) theory specifies that individuals with hostile styles may create an impression of threat, which results in avoidance and caution of other individuals around them. Furthermore, interactive styles of high hostile individuals may include displays that lack signs of appeasement or other affective behaviours that would contribute to diffusion of threat or conflict in interpersonal contexts, and thereby increase the risk of antagonistic social exchanges (Prkachin & Silverman, 2002). Thus, high hostile individuals may suffer socially because their behaviours contribute to avoidance by others and antagonistic interactions. Such consequences can be linked to health risks by decreasing an individual’s access to health-enhancing factors, such as social support and increasing exposure to pathogenic processes such as interpersonal stressors. Prkachin and Silverman’s 2002 study found that individuals high in hostility displayed lower rates of non-Duchenne smiles than participants low in hostility with responding to questions related to anger. These results support the theoretical standpoint that high hostile individuals experience lower levels of social support and higher levels of stressful life events than non-hostile people (Smith, 1992; Smith & Frohm, 1985). Of interest to the present study is

consideration of differences between hostile and non-hostile individuals in the context of health outcomes, and hypotheses build upon Smith's (1992) transactional model of hostility and health.

Heart Rate Variability and Vagal Tone

Heart rate and emotion theory. There is much literature in support of the *psychosomatic hypothesis* of stress and health, that psychological stress undermines optimal bodily functioning, therefore, increasing disease occurrence and mortality risks (Hilmert et al., 2010; Kiecolt-Glaser et al., 2002; McEwen, 1998). Despite some conflicting theoretical standpoints regarding the nature of emotion, it is generally accepted that emotions are multifaceted processes involving coordinated changes in peripheral and central physiology (Appelhans & Luecken, 2006; Thayer & Siegle, 2002). Generally, emotions experienced while interacting with the environment are associated with varying degrees of physiological arousal (Levenson, 2003).

More specifically, research examining the relationship between the nervous and cardiovascular systems in the context of emotion and physiology has increasingly focused on the physiological ability to control heart rate (Beauchaine, 2001; Porges, Doussard-Roosevelt, Portales, & Greenspan, 1996; Thayer & Lane, 2000). The concept of vagal tone (defined as the vagus nerve's regulation and control of heart rate) is implicated in this research. The vagus nerve innervates the heart at the sinoatrial node, and has direct influence on cardiac responding. Power spectral analysis of heart rate variability (HRV) is frequently utilized to assess the parasympathetic influence of the vagus nerve on the heart (Eckberg, 1983). To measure HRV, cardiac inter-beat intervals are decomposed into the frequencies contributing to HRV within the time period measured. Power within two frequency bands of the power spectrum are ordinarily examined: a high frequency band (HF: 0.15 - 0.40 Hz) and a low frequency band (LF: .05 - .15

Hz). HF measurements are generally believed to represent parasympathetic influences on heart rate (HR) coinciding with respiration whereas LF is believed to reflect both parasympathetic and sympathetic system activity. The ratio between high frequency and low frequency is considered a measure of autonomic balance.

There is a large literature base supporting both the idea that vagal tone (as measured by HRV) is a reliable predictor of positive health outcomes such as flexible emotional responding, and that diminished HRV is associated with poorer health outcomes (Tsuji et al., 1996). For example, research has shown a relationship between vagal tone and self-regulatory capabilities, adaptive emotional responding, self-management and attention focus processes, and social performance (Appelhans & Luecken, 2006; Denver, Reed, & Porges, 2007; DiPietro & Porges, 1991; Hofheimer, Wood, Porges, Pearson, & Lawson, 1995; Porges, 2003; Porges et al., 1996; Thayer & Lane, 2000). However, over regulation of emotions may become maladaptive by leading to alexithymia and poorer mental health outcomes (Neumann, Sollers, Thayer & Waldstein, 2004). Thus the concepts of adaptability and flexibility inherent in HRV are favoured as links to resilience in autonomic functioning. While there has been conflicting evidence regarding the relation between cardiovascular responses and health outcomes (Hilmert et al., 2010), it is generally accepted that individual differences in cardiovascular reactivity are reliable in long-term prediction of the development of hypertension and coronary heart disease (Stewart et al., 2006; Treiber et al., 2003). Prkachin and Silverman (2002) suggest further research into the transactional and physiological implications of smiling behaviours and facial expression may have potential to improve current understandings of biobehavioural mechanisms of cardiovascular function and disease.

The current study bases its hypothesis on the theoretical basis of HRV as a measure of vagal tone as an indicator of positive health outcomes, and conversely, the link between low HRV and increased risk of coronary heart disease mortality (Woo & White, 1994). Further, Prkachin and Silverman (2002) draw a link between hostility and smiling behaviours that suggests further research into understanding whether the smile may play a transactional role in understanding the link between hostility, HRV and health outcomes. The question in the current study is whether there are particular factors (i.e., smiling behaviour and hostility trait) that may relate to hostility and simultaneously *predict* heart rate variability, and in what way might these factors relate to one another. If the answers to these questions were positive, assuming that heart rate variability is a positive health indicator, this would suggest potential for further exploration with regard to positive health outcomes.

Implications for Disability Management

Disability Management (DM) is the coordinated efforts of employers to reduce and manage absences from work as a result of illness, injury or disability and on preventing the risks that cause absences. The focus of DM is on reducing occurrence and effect of illness and injury on workforce productivity and promotion of employee-workplace attachment. The three main components of DM are: prevention, support for recovery and accommodation (Dyck, 2002; Harder & Scott, 2005). DM within a resilience framework takes the perspective of disability and management of functional limitations resulting from disability, injury and illness in terms of an adaptive process allowing for a pro-active approach to understanding the underlying threads and contributing factors to discerning how some individuals cope effectively with adversity and others do not.

Heart disease and stroke costs the Canadian economy more than 20.9 billion dollars every year in physician services, hospital costs, lost wages and decreased productivity. Factors contributing to this are believed to include: an aging demographic, rising levels of work-related stress and ever increasing proportion of women in the workforce with multiple responsibilities (Conference Board of Canada, 2010). The significance of this statistic to employers includes, specifically, lost productivity and wages. It also highlights a historical focus on risk management and a recent shift to recognition of prevention as an effective approach to DM. The current study endeavors to contribute the increasing focus in DM on prevention through the examination of possible factors contributing to resilient cardiovascular health outcomes.

Hypotheses

Initial data analysis will consider whether smiles (Duchenne and non-Duchenne), during elicited emotions (anger and happiness), differ meaningfully in the context of gender and hostility levels (low and high).

Specifically, it is anticipated that women will display Duchenne and non-Duchenne smiles longer, more intensely and more frequently than men. It is also anticipated that lower hostility individuals will display Duchenne and non-Duchenne smiles longer, more intensely and more frequently than high hostility individuals. Since research shows that smiling may be linked to emotions, it is anticipated that Duchenne and non-Duchenne smiles will be displayed longer, more frequently and more intensely than during the happiness than the anger interview condition for all groups.

It is also hypothesized that low-hostile females will smile more than other groups, and will also display longer, more intense and more frequent smiles during the happiness interview

than the anger interview. The purpose of these analyses is to clarify relationships between smiling, hostility and gender.

Further analysis will be aimed at linking the smile data to physiological measures of heart rate variability to consider whether smile behaviors have the emotional regulatory effect at a physiological level as theorized in the literature. Specifically, it is anticipated that higher HF HRV will be predicted by lower hostility levels and more frequent, longer and more intense smiles.

Method

Participants

Participants were 121 undergraduates (64 females, 57 males) selected from the first 154 participants in the Psychophysiological and Behavioural Determinants of Cardiovascular Reactivity study, for which data collection began in 2003 at the University of Northern British Columbia. Selection for the current study was based on available coded data, with exclusion of participants with missing data. Participants for the original study were screened for participation based on their scores on three subscales of the Cook-Medley Hostility Scale that had been found by Barefoot, Dodge, Peterson, Dahlstrom and Williams (1989) to be the best predictors of mortality in a longitudinal study. Specifically, they were required to receive accumulated scores of ≤ 9 or ≥ 13 , on this “Barefoot index” (Prkachin & Silverman, 2002), by which scores they were included in the low-hostile ($N = 64$) and high-hostile ($N = 66$) groups.

Apparatus and Materials

The raw electrocardiogram (EKG) signal was recorded by placing three disposable commercial electrodes, using a Lead II configuration. The raw EKG was processed using a Biopac physiological recording system running AcqKnowledge 3.7 software. The raw EKG was

then processed offline using Mindware 2.0 software (Mindware, Gahana, OH) to calculate heart-rate variability indices.

Measures

All participants completed the *Barefoot index (Appendix B)* as part of the selection process for the study. In addition, they completed an *Emotion Sampling Form* that was used to structure emotion recall interviews described below.

The barefoot index (Appendix 2). The Barefoot index consists of the aggressive responding, cynicism and hostile attitudes subscales of the Cook-Medley Hostility Scale. The Cook-Medley Scale is 50-item true-false response self-report measure derived from the MMPI and designed to measure hostility (Cook & Medley, 1954). The most common measure for assessing hostility in health psychology (Zwaal et al, 2003), the Cook-Medley subscales *cynicism, hostile affect, and aggressive responding* was found to predict early mortality in a 23-year longitudinal study (Barefoot, 1992; Barefoot et al, 1989). Convergent and discriminant validity findings are supportive of interpreting the Cook-Medley as a measure reflective of hostility (Smith & Frohm, 1985). Construct validity studies of this measure indicate it primarily assesses suspiciousness, resentment, and cynical mistrust (Smith & Frohm, 1985).

Emotion sampling form (Appendix 3). The Emotion Sampling Form asked people to identify two incidents from their lives that they would be comfortable talking to someone about: the event that made them the angriest they have ever been, and the event that made them the happiest they have ever been. Participants provided written narrative descriptions, then responded, in writing, to a series of questions regarding the stimuli associated with the event.

Procedure

Session 1. For the original study, participants completed an initial session during which they completed the Emotion Sampling Form to determine the events that would be used to generate emotional experiences in the second session.

Session 2. In the second session, after being outfitted with physiological monitoring equipment, participants rested in an upright, seated position in a comfortable chair for ten minutes. A five-minute baseline period followed the rest period and then three successive six-minute interviews took place, each followed by a nine-minute recovery period. The timing for the emotional induction interviews was based on protocol extensively utilized in order to acquire sufficient data for the spectral analysis of heart-rate variability (Rash & Prkachin, 2012). The three successive six-minute standardized interviews, administered by trained research assistants, included the *anger interview* and the *happiness interview*, and *the daily events interview*.

The anger interview was adapted from previous work (Prkachin, Mills, Zwaal & Husted, 2001) and based on Ewart and Kolodnar's (1991) Social Competence Interview and Lang's (1979) theory of emotional imagery. The interview consisted of successive phases during which the participant was asked first to describe the "anger event", in detail. The interviewer followed this description by recapitulating the scenario and encouraging the participant to relive the experience in his or her imagination. The interviewer then asked a series of systematic questions, designed to encourage participants to articulate their thoughts, emotional and physical reactions, desires for outcomes, the behaviour of others in the situation, etc. The happiness interview followed the same format as the anger interview; however, it focused on the event described on the Emotion Sampling Form as the happiest moment in the participant's life. In addition to the anger and happiness interviews there was a daily events interview, which involved questions

about a daily event (i.e., “What did you eat for breakfast?”) not marked by any particularly strong emotion, meant to serve as a neutral control interview. Data from the *daily events* interview were not included in the current study due to issues related to availability of data. The interviews were implemented in a pre-determined, randomized order for each participant. At the end of each interview, participants rated the intensity of seven emotional states: *surprise, happiness, sadness, fear, disgust, anger, and stress* on 0 – 7 Likert scales, where “0” represented “no experience” of the emotion and 7 represented “extremely intense” emotion.

For the duration of the session, participants’ physiological responding was recorded in five one-minute intervals across each of three phases (baseline, elicited emotion interview, and recovery) resulting in five measurements for each interview condition as well as for the baseline and recovery periods.

Data processing. Video data from the interviews was coded by two trained research assistants utilizing a system based on Facial Action Coding System (FACS; Ekman & Friesen, 1978; Ekman, Friesen, & Hager, 2002) criteria to identify Duchenne and non-Duchenne smiles. Duchenne smiles are coded based on appearance changes caused by the zygomaticus major muscle pulling the lip corners up (AU 12 in FACS), and the orbicularis oculi pars lateralis muscle lifting the cheeks, narrowing the eye openings, and producing wrinkling around the eye socket (AU 6 in FACS). Non-Duchenne smiles are coded based on the presence of only AU 12 and the absence of AU 6 in FACS. Smile data were coded in terms of duration, frequency and intensity of each smile type (i.e., Duchenne and non-Duchenne) in each interview condition (i.e., happiness and anger). Duration scores were the length of time (in seconds) the smile took place. Frequency scores were derived by summing the number of each type of smile during each interview condition thereby producing four separate frequency scores for each participant, two

for each condition/smile scenario. Intensity ratings were given for each smile in each condition, and averaged to achieve one intensity score for each type of smile in each condition, thus resulting in four intensity scores for each participant.

Using Mindware, the EKG signal was first edited to remove erroneous R-R intervals, following the recommendations of Berntson, Quigley, Jang and Boynsen (1990). The signal was then processed in one-minute intervals to extract measures of power in the HF band to quantify RSA. The five measurements for each phase were then averaged resulting in three RSA variables per participant (baseline, anger and happiness conditions).

Results

Inter-rater reliability. Table 1 presents Pearson correlations between the original raters and the reliability rater for the frequency, intensity and duration of Duchenne and non-Duchenne smiles during both interviews.

TABLE 1

Inter-rater Reliability Correlations (Pearson's r) Among Smile Variables

Interview Condition	Duchenne	non-Duchenne
Anger		
Duration	.796**	.797**
Frequency	.962**	.829**
Intensity	.910**	.945**
Happiness		
Duration	.954**	.578**
Frequency	.909**	.559**
Intensity	.918**	.890**

****.** *Correlation is significant at the 0.01 level (2-tailed).*

Correlation coefficients for inter-rater reliability were all significant, with correlation magnitudes indicating data quality ranging from good to excellent. Scatterplots for non-Duchenne reliability scores for the happiness condition duration and frequency were examined,

revealing two outliers. Coding was reviewed in detail with the conclusion that the two coders were in disagreement on the two outliers. Otherwise, the correlation results support good data quality. On the strength of this analysis, it was concluded that the smile coding data could be appropriately analyzed using parametric statistical procedures.

Manipulation check. Participants' self-report ratings of happiness and anger were analyzed in a 2 (hostility level) X 2 (sex) X 3 (phases: baseline, post anger, post happiness) ANOVA. The ANOVA for happiness ratings resulted in a significant phase effect, Greenhouse-Geisser $F(1.74, 222.06) = 246.94, p < .001, \eta_p^2 = .66$. Post-hoc comparisons, using a Bonferroni correction, indicated that the mean happiness rating following the happiness interview ($M = 4.47, SE = .13$) was significantly greater and the mean happiness rating following the anger interview ($M = 1.84, SE = .12$) was significantly lower than the mean happiness rating at the end of baseline ($M = 3.43, SE = .11$). The comparable analysis for anger ratings resulted in significant main effects for hostility level, $F(1, 128) = 5.07, p < .05, \eta_p^2 = .04$, sex, $F(1, 128) = 6.47, p < .05, \eta_p^2 = .05$, and phase, Greenhouse-Geisser $F(1.36, 173.86) = 241.99, p < .001, \eta_p^2 = .65$. There was also a significant sex X phase interaction, $F(1.36, 173.86) = 8.80, p < .01, \eta_p^2 = .06$. Mean anger ratings for high hostile participants ($M = 1.15, SE = .09$) were higher than those for low hostile participants ($M = 0.84, SE = .10$). Mean anger ratings for women ($M = 1.17, SE = .09$) were higher than those for men ($M = 0.82, SE = .10$). All three phase means differed significantly according to Bonferroni comparisons, with the mean anger rating following the anger interview ($M = 2.51, SE = .14$) being significantly higher and the mean anger rating following the happiness interview significantly lower ($M = 0.15, SE = .04$) than the mean anger rating at the end of baseline ($M = 0.32, SE = .08$). The interaction was accounted for by

differentially higher anger ratings among women following the anger interview (women's $M = 2.97$, $SE = .20$; men's $M = 2.05$, $SE = .21$).

The Relationship Between Gender, Hostility-level, Elicited Emotion and Smile Type

Descriptive statistics in relation to hostility level for the main dependent variables – frequency, intensity and duration of smile type (i.e., Duchenne and non-Duchenne) in each interview condition – are presented in Table 2. Descriptive statistics in relation to gender are presented in Table 3.

TABLE 2
Means and Standard Deviations of Dependent Variables by Hostility

Interview/Smile Condition	Low Hostility		High Hostility	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Anger/Duchenne				
Duration	10.58	13.64	10.26	11.27
Intensity	2.49	1.42	2.52	1.28
Frequency	5.09	6.16	4.37	4.45
Anger/Non-Duchenne				
Duration	12.53	15.12	10.21	12.6
Intensity	2.41	1.06	2.04	1.17
Frequency	4.63	4.08	3.29	2.62
Happiness/Duchenne				
Duration	15.66	15.41	14.08	13.68
Intensity	3.55	.889	3.20	.803
Frequency	8.21	7.03	8.43	5.47
Happiness/Non-Duchenne				
Duration	3.00	4.39	2.85	3.60
Intensity	.992	1.30	1.32	1.27
Frequency	2.11	3.62	1.99	2.93

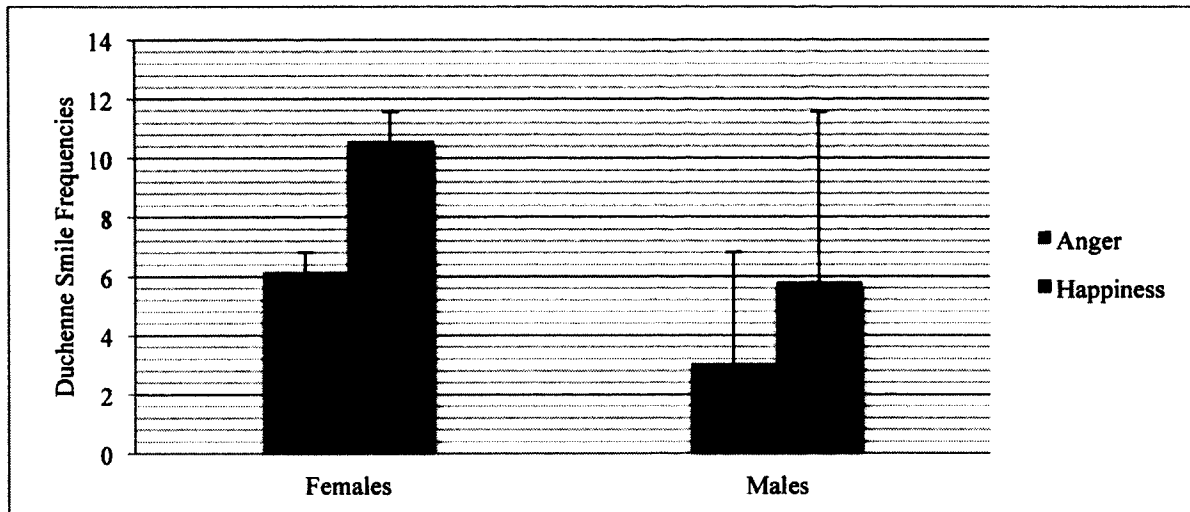
TABLE 3
Means and Standard Deviations of Dependent Variables by Gender

Interview/Smile Condition	Females		Males	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Anger/Duchenne				
Duration	10.45	11.62	10.36	13.27
Intensity	2.59	1.19	2.41	1.49
Frequency	6.17	6.25	3.05	3.32
Anger/Non-Duchenne				
Duration	12.36	14.52	10.08	13.00
Intensity	2.37	1.08	2.04	1.16
Frequency	4.58	3.68	3.16	2.97
Happiness/Duchenne				
Duration	14.06	12.85	15.65	16.15
Intensity	3.37	.648	3.35	1.05
Frequency	10.58	6.94	5.81	4.03
Happiness/Non-Duchenne				
Duration	3.75	4.43	2.00	3.17
Intensity	1.42	1.38	.88	1.13
Frequency	2.58	3.56	1.44	2.78

To examine the influence of gender, hostility level (low and high), and elicited emotion (happiness and anger) on smiling behaviours, three-factor (gender X hostility X interview condition) Repeated Measures Analyses of Variance (RM-ANOVAs) were conducted, with repeated measures on the interview factor. Analyses were conducted separately for Duchenne and non-Duchenne smiling frequency, intensity and duration measures.

Duchenne smiles. The analysis of Duchenne smile frequencies revealed a main effect of interview, $F(1, 117)=99.08, p<.001, \eta_p^2=.46$) and gender, $F(1, 121)=18.10, p<.001, \eta_p^2=.13$; and a significant gender X interview interaction, $F(1, 117) = 4.89, p<.05, \eta_p^2=.04$. The interaction is shown in Figure 1, where it can be seen that Duchenne smiles occurred more frequently during the happiness interview than during the anger interview, particularly among women.

FIGURE 1
Gender X Interview interaction for Duchenne Smile Frequencies



The comparable analysis of Duchenne smile intensities revealed only a main effect for interview, $F(1, 117) = 55.64, p < .001, \eta_p^2 = .32$. Similar to the frequency analysis, smiles during the happiness interview ($M = 3.38, SE = .08$) were more intense than those during the anger interview ($M = 2.50, SE = .12$).

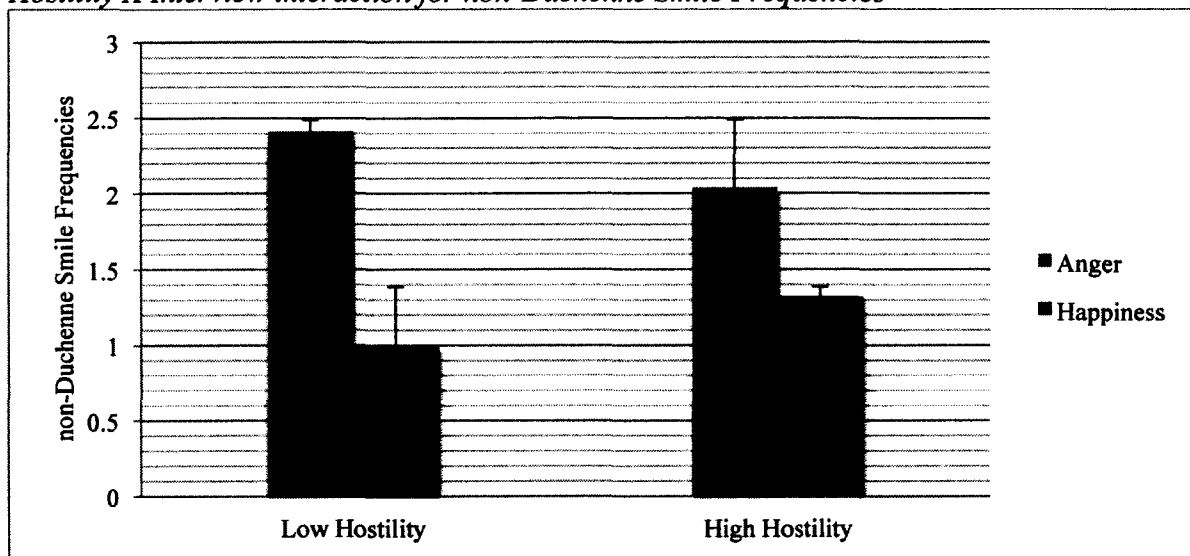
The analysis of Duchenne smile durations, like the analysis of intensities, revealed only a main effect for interview, $F(1, 117) = 7.08, p < .01, \eta_p^2 = .06$. Smiles during the happiness interview ($M = 10.36, SE = 1.14$) were more intense than those during the anger interview ($M = 14.85, SE = 1.32$).

Non-Duchenne smiles. The analysis of non-Duchenne smile frequencies revealed a significant main effect for interview, $F(1, 117) = 58.23; p < .001; \eta_p^2 = .33$, a significant main effect for gender, $F(1, 117) = 5.92; p < .05, \eta_p^2 = .05$, and a significant hostility group X interview interaction, $F(1, 117) = 5.93, p < .05; \eta_p^2 = .05$. Women ($M = 2.29, SE = .37$) exhibited more frequent non-Duchenne smiles than men ($M = 2.29, SE = .39$). The interaction is shown in Figure

2. By contrast with the analysis of Duchenne smiles, non-Duchenne smiles were more frequent during the anger interview than the happiness interview, during which low hostile participants showed a higher frequency of smiles than high-hostile participants. During the happiness interview, there was no significant difference in the rates of non-Duchenne smiling between low and high hostile participants.

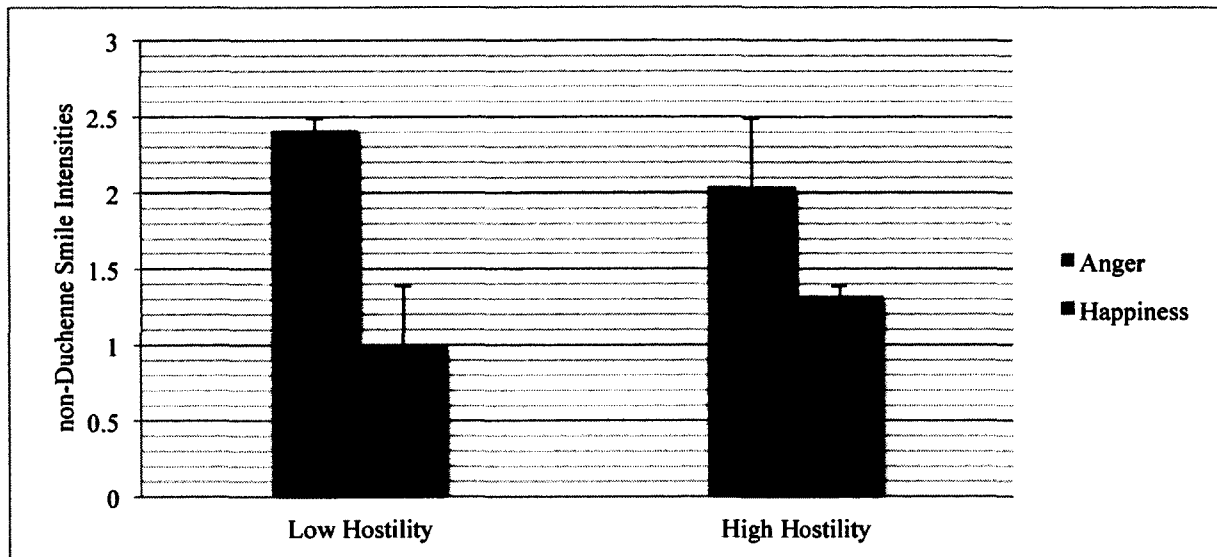
FIGURE 2

Hostility X Interview interaction for non-Duchenne Smile Frequencies



The analysis of non-Duchenne smile intensities showed similar findings. There was a significant main effect for interview, $F(1, 117) = 49.39$; $p < .001$; $\eta_p^2 = .30$, a significant main effect for gender, $F(1, 117) = 8.28$; $p < .01$, $\eta_p^2 = .07$, and a significant group X interview interaction, $F(1, 117) = 5.55$, $p < .05$; $\eta_p^2 = .05$. Women ($M = 1.89$, $SE = .10$) smiled more intensely than men ($M = 1.46$, $SE = .11$). The interaction, shown in Figure 3, was comparable to that shown in the analysis of non-Duchenne smile frequencies, with low hostile participants showing a greater intensity of non-Duchenne smiling than high-hostile participants during the anger interview and the opposite pattern during the happiness interview, with smiling intensity being greater, on average during the anger interview.

FIGURE 3
Hostility X Interview interaction for non-Duchenne Smile Intensities



The analysis of non-Duchenne smile durations resulted only in a significant interview effect, $F(1, 117) = 36.94$; $p < .001$; $\eta_p^2 = .24$. Average durations of non-Duchenne smiles during the anger interview ($M = 11.27$, $SE = 1.27$) exceeded those during the happiness interview ($M = 2.85$, $SE = 0.36$).

Do Hostility, Smiling and Elicited Emotions Affect RSA?

To examine the relationship between smiling behaviours, and vagal tone (heart rate variability measured by RSA), an initial correlation analysis was conducted correlating the three RSA variables (average RSA during baseline, happiness and anger interviews) with each of the smiling variables: Duchenne and non-Duchenne intensity, frequency and duration in each of the interview conditions. There were no significant correlations found with this analysis. Tables 4 and 5 depict the correlation results among the RSA measurements and Duchenne and non-Duchenne smile variables, respectively. In neither set of analyses did any correlation between a smiling variable and a RSA variable achieve statistical significance.

TABLE 4

Correlations (Pearson's r) Among RSA and Duchenne Smile Variables

Interview Condition	RSA Baseline	RSA Anger Average	RSA Happiness Average
Anger			
Duration	-.082	-.144	-.098
Frequency	-.027	.118	.177
Intensity	.078	.005	.030
Happiness			
Duration	.000	-.040	-.086
Frequency	-.058	.021	.083
Intensity	.040	.009	.047

TABLE 5

Correlations (Pearson's r) Among RSA and non-Duchenne Smile Variables

Interview Condition	RSA Baseline	RSA Anger Average	RSA Happiness Average
Anger			
Duration	.000	-.062	-.075
Frequency	-.033	-.005	.011
Intensity	-.019	-.067	-.126
Happiness			
Duration	-.092	-.034	-.024
Frequency	-.137	-.027	-.044
Intensity	-.172	-.095	-.080

In view of the absence of any significant correlations between smiling and RSA variables in this analysis, there appeared to be little likelihood of obtaining any meaningful relationship among the other study variables, smiling and RSA and no further analysis was conducted.

Discussion

The analyses of participants' self-report ratings of anger and happiness at the end of the baseline phase and at the end of each interview indicated that, after being interviewed about an experience that the participant indicated had made them extremely angry, participants in general

reported being more angry and less happy than they were at baseline. Conversely, after being interviewed about an experience that had been identified as having generated strong happiness, participants reported being more happy and less angry than they had been at baseline.

Consequently, the self-report ratings provided validation that the recalled-experiences interviews had the intended effects by provoking the targeted emotions. The fact that hostile participants' anger ratings were significantly greater on average and that hostility level did not interact with phase suggests that hostile participants do, indeed, carry with them a generally higher level of anger much of the time, a finding that is consistent with expectations arising from the construct of hostility. Curiously, in the present study, women appeared to play counter to stereotypic expectations by reporting stronger anger overall and particularly stronger anger following the anger interview than men. It seems possible that the specific anger experiences that women chose to focus on may have been in some fundamental way more inherently provocative than the experiences selected by men and that this could have in effect artifactually increased the overall mean anger rating, resulting in both the significant interaction and main effect for sex. In any case, the overall findings from the self-report ratings suggest that the interviews did indeed have their intended specific emotional effects.

The Relationship Between Gender, Hostility-level, Smile Type, and Elicited Emotion

In each of the ANOVAs, the interview condition significantly affected the frequency, intensity and duration, of both Duchenne and non-Duchenne smiles. Overall, women displayed more of both types of smile than men in both interview conditions. This finding is consistent with the literature on emotional expression in women and men (Brody & Hall, 2000).

Duchenne smiles were overall more frequent, intense and longer during the happiness interview than the anger interview for both males and females. Conversely, non-Duchenne

smiles were more frequent, intense and longer during the anger condition than the happiness condition for both genders. This is an interesting finding that regardless of gender or hostility level, individuals in this cohort demonstrated higher levels of Duchenne smiles when happy and higher levels of non-Duchenne smiles when angry. These findings support current theories that suggest the Duchenne smile is an “enjoyment” smile and, perhaps, the non-Duchenne as a “non-enjoyment” smile (Ekman, 1982, 1992a; Ekman & Friesen, 1969). It further supports theories of the non-Duchenne smile as a social functioning smile meant to mediate social circumstances (Gervais & Wilson, 2005). In other words, undergoing conditions eliciting happiness results in a display of positive emotion (Duchenne smile) and undergoing conditions eliciting anger brings forth a behavioural display that is possibly meant to politely mediate the social circumstances. It has been noted that the non-Duchenne smile is somewhat problematic in the literature (Prkachin & Silverman, 2000) in that it is neither understood to be a display of positive nor negative emotions. One explanation as to why a non-Duchenne smile may be displayed in such circumstances might be, as Prkachin and Silverman (2002) point out, that it is a gesture of appeasement (Fridlund, 1994) or submission – essentially, non-hostility.

Perhaps the most interesting finding is the role hostility played in the non-Duchenne smile displays: low-hostile individuals displayed non-Duchenne smiles more frequently and intensely than high-hostile individuals during the anger condition. These findings are a strong replication of Prkachin and Silverman’s (2002) findings that high-hostile individuals displayed lower rates of non-Duchenne smiles than low-hostile individuals.

Expressive behaviour, such as smiling, may suggest the ability to self-regulate and increase access to coping resources to deal with adversity. Research on the construct of hostility reports it is potentially a predictor of poorer health prognoses (Booth-Kewley & Friedman, 1987;

Miller et al., 1996; Rozanski, Blumenthal & Kalplan, 1999; Smith, 1992). To better understand the hostility-health outcome relationship, delving further into literature examining the behaviour of hostile individuals reveals a greater likelihood of negative affect expressions among hostile individuals than non-hostile individuals (Chesney et al., 1990), however, Prkachin and Silverman “found no relationship between expressions of negative emotions and hostility” (2000, p. 37). They did, however, find that the non-Duchenne smile was related to low-hostility, which was replicated in this study. In essence, the behaviour of high-hostile individuals may not clarify the hostility-health relationship as much as the *absence* of a particular behaviour does, specifically, the non-Duchenne smile displayed by low hostile individuals that was not displayed by high-hostile individuals during anger scenarios.

From an evolutionary perspective, theorists suggest the non-Duchenne smile is not directly linked with affective expression, but developed as an adaptive mechanism to moderate social circumstances (Gervais & Wilson, 2005). It is commonly understood to be a “polite” smile, meant to mask negative emotions (Ekman & Friesen, 1982). In the present study, individuals were in anger-eliciting situations, and the behaviour of non-hostile individuals could be interpreted as a signal of politeness. Prkachin and Silverman (2000) conceived a novel conception of hostility, suggesting the behavioural ecology perspective of non-Duchenne smiles as “gesture of appeasement...or an indication that there is little to fear” (p. 37) or, in other words, meant to convey something along the lines of “I am discussing unpleasant things because the situation calls for it, but you have nothing to worry about from me” (p. 37). They suggest the lack of non-Duchenne smiles from high-hostile individuals might be appropriately interpreted to communicate the message, “Take me seriously, I am not made uncomfortable by antagonistic

situations” (p. 37). This analysis could be applied to the current study, emphasizing interpersonal behaviour.

This conceptualization of hostility can help explain the high-hostility link to poor health by emphasizing the individual’s behaviour (or, in a high-hostile person’s case, lack thereof) and the social transactions resulting. For example, a low-hostile individual in a situation inducing anger smiles to show, essentially, that although the *situation* may be a hostile one, *she* is not. By communicating that she is not hostile in a hostile scenario, the other person’s behaviours may be impacted in a positive way, resulting in a more positive social interaction overall. This analysis is consistent with Smith’s (1992) theory that suggests hostility is associated with risk via transaction between the hostile individual’s behaviours in the social world and the reciprocation of the social world as a result. More specifically, individuals with hostile interaction styles may create an impression of threat, which results in avoidance and caution of others. Furthermore, interaction styles of high hostile individuals may include displays that lack signs of appeasement or other affective behaviours that would contribute to diffusion of threat or conflict in interpersonal contexts, thus increasing antagonistic social exchanges (Prkachin & Silverman, 2002).

Do Hostility, Smiling and Elicited Emotions Impact RSA?

High and low hostile subjects participated in a well-established interview condition to evoke specific emotions (happiness and anger), during which smile behaviours and RSA were measured. This research established a relationship between hostility and smiling behaviour, however, neither type of smiling was predictive of RSA in this study. This may suggest there is not a relationship between smiling and RSA or that there is a methodological problem that prevented the relationship from being observed. Considering that smile behaviours varied

meaningfully as a function of gender and interview condition, and inter-rater reliability values were sufficient to indicate good data quality, it may be worthwhile to consider other ways in which smiling behaviours might impact the hostility-health relationship.

RSA is known to be a predictor of positive cardiovascular outcomes, and has also been shown to relate to self-regulatory capabilities, adaptive emotional responding, self-management and attention focus processes, and social performance (Appelhans & Luecken, 2006; Denver, Reed, & Porges, 2007; DiPietro & Porges, 1991; Hofheimer, Wood, Porges, Pearson, & Lawson, 1995; Porges, 2003; Porges et al., 1996; Thayer & Lane, 2000), factors that are also often conceived as factors contributing to resilience. In sum, resilience predicts health outcomes (poorer resilience leads to negative health outcomes), hostility predicts health outcomes (higher hostility leads to poorer health outcomes), and RSA predicts factors related to resilience. The results of this study showed that hostility is predictive of smiling behaviours (high hostility predicts lower smiling). Therefore, the question remains: Does smiling predict RSA, and could this predictive relationship partially account for the process of resilience. Although it was thought smiling behaviour might indicate an internal process of emotional regulation that involves EF and thereby promotes resilience through an influence on cardiac vagal control, the results do not support this. Therefore, if smiling does contribute to resilience, it must do so through some process other than the physiological events contributing to RSA.

There is little question that positive emotions are linked to positive health outcomes and that hostility is linked with poorer health outcomes. The concept of *EF* is based on a culmination of research suggesting both suppression and expression of emotion have different and important interpersonal and intrapersonal functions (Westphal, Seivert, & Bonanno, 2010). There is research that shows habitual suppression of emotion has negative outcomes (Butler et al., 2003;

Gross & John, 2003; Gross & Levenson, 1993, 1997; Richards, Butler, & Gross, 2003), but also that there are times when suppression of down-regulation of emotion is adaptive (Bonnano & Keltner, 1997; Gross & Munoz, 1995; Keltner, Kring, & Bonanno, 1999; Kennedy-Moore & Watson, 2001). So, based on this, it was hypothesized that the expression of smiling may be a worthwhile factor to explore in the hostility-health relationship. If the non-Duchenne smile is an intentional gesture of appeasement, it was thought that perhaps it is a component of the concept of *EF* in action. The smile, however, does not seem to function in the way predicted in the hostility-emotion-RSA relationship.

If it is true that smiling is less an indication of internal emotions experienced and more a functional behaviour mediating social interactions, it may be more appropriate to examine smiling in the context of social interactions and health outcomes. Future research might focus on dyads of participants interacting and consider the impact of smiling behaviours on interactions between individuals. Do two hostile individuals interact differently during evoked emotions than two low hostile individuals? Does a low hostile individual behave in a way that affects interactions with high hostile individuals? Do these interactions affect individuals' RSA in a meaningful way? Another interesting line of exploration might involve delving into the perceptions of low- and high-hostile individuals during the evoked emotion scenarios. If low hostile individuals display non-Duchenne smiles during evoked anger to communicate they are not hostile despite uncomfortable circumstances, perhaps there is something fundamentally different about how low- and high-hostile individuals perceive scenarios that induce particular emotional states. Perhaps exploring more about the internal thought processes of these individuals might clarify the intent behind the smile or, perhaps, their emotional processes when in such situations.

Implications for Disability Management

The implications of these findings for Disability Management (DM) are important to demonstrate that DM programming and interventions cannot be a “one-size fits all” to be effective. Many conversations, interviews and assessments that take place during the DM process elicit negative emotions and may be uncomfortable for the interviewee. For the DM professional, understanding that women and men behave differently during evoked emotional circumstances, and that high- and low-hostile individuals will also behave differently may be useful for the DM professional to tailor the approach to potentially emotional conversations. Understanding that facial expression during specific situations may distinguish people who vary in hostility may be helpful to the DM professional to better understand the individuals they are working with and deepen the understanding of potential health risks to their clients. Further research delineating the underlying emotional processes and/or perceptions of individuals during such emotional circumstances may help to further clarify processes contributing to resilience in the DM construct.

Conclusions

The analyses showed that smile parameters varied meaningfully as a function of the type of elicited emotion interview people underwent and as a function of gender and hostility level. These analyses provided three specific findings: 1) Duchenne smiles are more commonly displayed during scenarios evoking happiness and non-Duchenne smiles are more commonly displayed during anger situations, 2) women smile more than men and 3) low-hostile individuals display more non-Duchenne smiles during elicited anger scenarios than high-hostile individuals. The analyses did not demonstrate a relationship between smiling behaviours and RSA. Future research might focus on the social-transactional nature of the smile by examining dyads of

participants interacting to consider whether there are any meaningful differences among genders and hostility levels, or delve in the perceptions of people who vary in hostility to further understand the emotional process and intention behind specific smile displays.

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Appendix 1: Contractual Agreement Between Parties

Appendix 2: The Barefoot Index

**University of Northern B.C.
Psychophysiology Lab**

CM Questionnaire

Please read these instructions:

- This inventory consists of numbered statements. Please read each statement and decide whether it is true or false as it applies to you.
- If a statement is true, or mostly true **as it applies to you**, circle the word TRUE.
- If a statement is false, or mostly false **as it applies to you**, circle the word FALSE.
- If a statement does not apply to you, or if you are unclear as to how to respond, **DO NOT** circle any word.
- Remember to give **your own opinion of yourself**. Try not to leave any statements unanswered if you can avoid it.

- | | | |
|----------------------------------|-----------------------------------|---|
| True
<input type="checkbox"/> | False
<input type="checkbox"/> | 1. When I take a new job, I like to be tipped off on who should be gotten next to. |
| True
<input type="checkbox"/> | False
<input type="checkbox"/> | 2. When someone does me wrong, I feel I should pay him back if I can, just for the principle of the thing. |
| True
<input type="checkbox"/> | False
<input type="checkbox"/> | 3. I prefer to pass by school friends, or people I know but have not seen for a long time, unless they speak to me first. |
| True
<input type="checkbox"/> | False
<input type="checkbox"/> | 4. I have often had to take orders from someone who did not know as much as I did. |
| True
<input type="checkbox"/> | False
<input type="checkbox"/> | 5. I think a great many people exaggerate their misfortunes in order to gain the sympathy and help of others. |
| True
<input type="checkbox"/> | False
<input type="checkbox"/> | 6. It takes a lot of argument to convince most people of the truth. |
| True
<input type="checkbox"/> | False
<input type="checkbox"/> | 7. I think most people would lie to get ahead. |
| True
<input type="checkbox"/> | False
<input type="checkbox"/> | 8. Someone has it in for me. |
| | | 9. Most people are honest chiefly through fear of being caught. |

- | | | |
|--------------------------|--------------------------|--|
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 10. Most people will use somewhat unfair means to gain profit or an advantage rather than to lose it. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 11. I commonly wonder what hidden reason another person may have for doing something nice for me. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 12. It makes me impatient to have people ask my advice or otherwise interrupt me when I am working on something important. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 13. I feel I have been punished without cause. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 14. I am against giving money to beggars. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 15. Some of my family have habits that bother and annoy me very much. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 16. My relatives are nearly all in sympathy with me. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 17. My ways of doing things are apt to be misunderstood by others. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 18. I don't blame anyone for trying to grab everything he can get in this world. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 19. No one cares what happens to you. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 20. I can be friendly with people who do things which I consider wrong. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 21. It is safer to trust nobody. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 22. I do not blame a person for taking advantage of someone who lays himself open to it. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 23. I have often felt that strangers were looking at me critically. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 24. Most people make friends because friends are likely to be useful to them. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 25. I am sure I am being talked about. |

- | | | |
|--------------------------|--------------------------|--|
| <input type="checkbox"/> | <input type="checkbox"/> | |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 26. I am likely not to speak to people until they speak to me. |
| True | False | 27. Most people inwardly dislike putting themselves out to help other people. |
| <input type="checkbox"/> | <input type="checkbox"/> | |
| True | False | 28. I tend to be on guard with people who are somewhat friendlier than I had expected. |
| <input type="checkbox"/> | <input type="checkbox"/> | |
| True | False | 29. I have sometimes stayed away from another person because I feared doing or saying something that I might regret afterwards. |
| <input type="checkbox"/> | <input type="checkbox"/> | |
| True | False | 30. People often disappoint me. |
| <input type="checkbox"/> | <input type="checkbox"/> | |
| True | False | 31. I like to keep people guessing what I'm going to do next. |
| <input type="checkbox"/> | <input type="checkbox"/> | |
| True | False | 32. I frequently ask people for advice. |
| <input type="checkbox"/> | <input type="checkbox"/> | |
| True | False | 33. I am not easily angered. |
| <input type="checkbox"/> | <input type="checkbox"/> | |
| True | False | 34. I have often met people who were supposed to be experts who were no better than I. |
| <input type="checkbox"/> | <input type="checkbox"/> | |
| True | False | 35. I would certainly enjoy beating a crook at his own game. |
| <input type="checkbox"/> | <input type="checkbox"/> | |
| True | False | 36. It makes me feel like a failure when I hear of the success of someone I know well. |
| <input type="checkbox"/> | <input type="checkbox"/> | |
| True | False | 37. I have at times had to be rough with people who were rude or annoying. |
| <input type="checkbox"/> | <input type="checkbox"/> | |
| True | False | 38. People generally demand more respect for their own rights than they are willing to allow for others. |
| <input type="checkbox"/> | <input type="checkbox"/> | |
| True | False | 39. There are certain people whom I dislike so much that I am inwardly pleased when they are catching it for something they have done. |
| <input type="checkbox"/> | <input type="checkbox"/> | |
| True | False | 40. I am often inclined to go out of my way to win a point with someone who has opposed me. |
| <input type="checkbox"/> | <input type="checkbox"/> | |
| True | False | 41. I am often not in on the gossip and talk of the group I belong to. |

- | | | |
|--------------------------|--------------------------|---|
| <input type="checkbox"/> | <input type="checkbox"/> | |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 42. The man who had most to do with me when I was a child (such as my father, stepfather, etc.) was very strict with me. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 43. I have often found people jealous of my good ideas, just because they had not thought of them first. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 44. When a man is with women he is usually thinking about things related to her sex. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 45. I do not try to cover up my poor opinion or pity of a person so that he won't know how I feel. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 46. I have frequently worked under people who seem to have things arranged so that they get credit for good work but are able to pass off mistakes onto those under them. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 47. I strongly defend my own opinions as a rule. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 48. People can pretty easily change me even though I thought that my mind was already made up on a subject. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 49. Sometimes I am sure that other people can tell what I am thinking. |
| True | False | |
| <input type="checkbox"/> | <input type="checkbox"/> | 50. A large number of people are guilty of bad sexual conduct. |

Appendix 3: Emotion Sampling Form

CVD Study Emotion Sampling Form

The purpose of this part of the study is to investigate the kinds of experiences you have when you feel angry and the kinds of experiences you have when you feel happy. To do this investigation, it will be most helpful to generate imagery based on your own life experience. For this reason, we would like you to remember two separate incidents from your past. These two separate incidences are: 1) when you felt the angriest you have ever been and 2) when you felt the happiest you have ever been. Please take your time to remember each of these incidences and then use the following Angry Incident Description sheets and Happy Incident Description sheets that have been provided to discuss each of them separately.

If you feel that a particular incident is too traumatic or personal to recall, or if you feel that you would not be able to talk about it, consider recalling some other incident that will elicit the same emotion.

Session 2 Date and Time: _____

If you have any questions, or need to cancel or re-schedule your session please contact XXX
(123-4567, XXX@unbc.ca)

IMPORTANT: Please make sure to bring these sheets completely filled out to your next session. We also ask that all of our participants in the study refrain from drinking caffeine, eating chocolate, smoking cigarettes and exercising 3 hours before each experimental session.

Anger Experience

We would like you to take some time and recall an experience in your life during which you felt the **angriest** you have ever felt.

Who was the person or persons with whom you were angry?

Please write a description of what happened below:

Where were you at the time? What could you see, hear and smell around you?

Who/what was it that caused you to get so angry? How did it/he/she enter the scene? What did it/he/she look like? What were they wearing?

What happened that made you so angry? What did he/she do or say to you?

How did you react? What did you say or do in return?

What were you thinking to yourself throughout the incident?

Did your body respond in any way? Did your heart start beating faster? Did your muscles tense up?

What other aspects of the situation or object/person added to your anger?

Did the way you reacted also add to your anger?

Happy Experience

We would like you to take some time and recall an experience in your life during which you felt the **happiest** you have ever felt.

Who was the person or persons with whom you were happy?

Please write a description of what happened below:

Where were you at the time? What could you see, hear and smell around you?

Who/what was it that caused you to feel so happy? How did it/he/she enter the scene? What did it/he/she look like? What were they wearing?

What happened that made you so happy? What did he/she do or say to you?

How did you react? What did you say or do in return?

What were you thinking to yourself throughout the incident?

Did your body respond in any way? Did your heart start beating faster? Did your muscles tense up?

What other aspects of the situation or object/person added to your happiness?

Did the way you reacted also add to your happiness?